RESEARCH REPORT

1965-1966

Research Station

LACOMBE, ALBERTA

H BRANCH - CANADA DEPARTMENT OF AGRICULTURE

Research Report

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Research Branch
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CONTENTS

FOREWORD

This report summarizes the main research findings for 1965 and 1966 at the Research Station, Lacombe. The numbers below the headings in the text refer to relevant research papers and articles listed under "Publications." Reprints of most publications are available on request.

It will be noted that our name has been changed from Experimental Farm to Research Station. This was done in 1966 to conform with the uniform designations of units of the Research Branch. There has been no change in our function, which is to conduct research for the solution of agricultural production problems, particularly those of central Alberta.

The diverse soil and climatic conditions in central Alberta present problems to production as well as a challenge to research. The more recently occupied Gray Wooded soils present special fertility and physical problems and the longer cropped soils are showing fertility requirement changes. The fact that some of the latter now respond to potassium and sulfur fertilizers, whereas earlier experiments did not indicate this requirement, is indicative of this change. It is also further evidence of the need for a continuing research program.

J. G. Stothart
Director

April 1967

1579—2

WEATHER

As the weather can influence field experiments as well as production, meteorological data have been recorded daily at Lacombe since 1907. The following summaries for 1965 and 1966 indicate one of the important sources of yearly variations in research results.

In 1965 spring soil moisture was excellent and precipitation was well above normal throughout the growing season. Hay and cereal crops were very heavy and lodging was common. September was wet with frequent light showers allowing very little threshing and causing discoloring and sprouting of grain in the swath. Precipitation in October was only 0.07 inch and caused little interference with the harvest. The killing frost free period was 128 days, from May 7 to September 12.

The 1966 season began with ample soil moisture reserves. Precipitation during April, May, and June was only 50% of normal. Late germination of wild oats caused a heavy infestation in many fields. Precipitation was well below normal all summer, but rains were timely. Favorable weather in September and October allowed harvest to be completed with little delay. The killing frost free period of 140 days, from May 13 to September 30, was 22 days longer than the 59-year average.

ANIMAL SCIENCE

Beef Cattle

Selection for Yearling Weight

The sixth year of selection for yearling weight has now been concluded in a closed Shorthorn herd comprising 180 females and 12 males. A contemporary control herd of 90 females and 6 males provides the basis for estimating genetic change. Substantial upward trends in yearling weights have been observed in both lines indicating a marked improvement in environment. At the same time, the lines have diverged at the rate of approximately 7.4 lb/year. The average response has been of the order of 0.50 ± 0.20 units of gain per unit of selection. This is a realized heritability of 50%.

Population Structure of the Hereford Breed in Canada

24

Registration certificates were issued in Canada for 75,000 Herefords during 1964. These registrations originated in 5,900 herds and represented 10,509 sires. Fifteen percent of all herds are represented by a single registration with 51% registering five or fewer animals. Eight percent of all herds registered 26 or more (high of 154 head) and accounted for 32% of all registrations.

1579—2½

Population Structure of the Yorkshire Breed in Canada

The size and continuity of herds of the Yorkshire breed were estimated from pedigree records for 58,404 Yorkshire pigs registered during the period 1959-62. Eighty percent of the herds from which pigs were registered were represented by five or fewer sows. These accounted for 41% of the total registrations. Numbers of sires in individual herds ranged from one to thirteen with 56% of the herds represented by a single sire and 81% by one or two sires. Herds of the latter category accounted for 49% of total registrations.

The number of herds involved in 1959 was 1,368. Two-thirds of these had ceased operations by 1962. Herds that discontinued registrations averaged smaller in size than those that continued to function. They were replaced by herds of approximately the same size.

Average inbreeding in the breed in 1962 was 7.0%. This represented an increase of 0.33% per generation since establishment of pedigree records for the breed in Canada. There was no evidence of strain formation.

Population Structure of the Lacombe Breed

During the period 1961-64, 5,195 purebred Lacombe pigs were registered by 131 private breeders across Canada, an average of approximately 40 pigs per breeder. Of the breeders who registered animals 48% registered fewer than 16 pigs and these amounted to 8% of the total registrations. At the other extreme, 11% of the breeders contributed 52% of the total registrations.

Selective Registration in the Lacombe Breed

Lacombe boars are accepted for registration provided that their littermates or their parents have been tested on R.O.P. and have met specified standards of carcass quality and growth rate or feed requirements. During the period of time under study, 1,081 Lacombe litters completed the R.O.P. test required for establishing registration status. Of these litters, 25% failed to meet the standards required and were culled. The 1,310 boars and 1,510 gilts that were registered on the basis of littermate performance averaged 82.6 for carcass score and 165 days in age at 200 lb liveweight. These figures were 21 and 15% above the minimum requirements for registration. These levels of performance exceeded breed averages for these traits by approximately half the standard deviation of litter averages.

Records for 1,672 Lacombe litters tested under the R.O.P. (swine) policy during the period 1958-65 were analyzed. The sires and dams of the test litters had sib-test records that were above the population average for carcass traits and growth rates, thus establishing that selection had been practiced. Regression of progeny performance on parental sib performance provided estimates of heritability that, although generally lower than estimates reported in the literature, were of sufficient magnitude to favor genetic improvement. However, the changes in breed performance over this period did not differ significantly from zero.

One of the contributing factors to the apparent failure of selection to produce improvement may have been errors in selection attributable to differences in between-herd environment. Only 25% of the sire–progeny records were made in

the herd in which the sire was born. For most traits, it was observed that regression of progeny performance on the performance of parental sibs was substantially larger than where the sire was obtained from another breeder. Generation interval may also have been a contributing factor. A precise estimate of generation interval was not obtained, but, during the period under study, 86% of the sires used were of the foundation (1959) generation.

Litter Size and Sex Balance in Pig Testing

7

The effects of minimum standards for litter size and sex balance on swine performance tests programs were examined. In approximately 16% of all gilt litters fewer than four pigs were weaned and thus the litter was unable to meet the conventional standard of four pigs for litter testing. Imposing the restriction that the sexes be equally represented in the test group eliminated an additional 15% or more of the litters. The further restriction that at least six pigs be weaned excluded another 10%. In practice, the net result of these restrictions was the elimination of from 41 to 56% of all gilt litters, a proposition that is detrimental to the development of constructive selection programs. Essentially the same figures would apply to second and subsequent litters. Review of the genetic evidence pertaining to these restrictive regulations suggested that they have no technical validity and are unwarranted in programs supporting selective improvement.

Cryptorchidism in the Pig

32

It has been determined that two forms of cryptorchidism exist. One is characterized by failure of one or both of the testicles to descend into the normal scrotal position. The other appears to result from atrophy of one or both gonads after they have descended to the normal position. The two conditions are phenotypically identical in live pigs and can be separated only by autopsy.

The inheritance of these two forms of cryptorchidism has been examined by breeding studies conducted within two closed populations. In both populations, all sires used for breeding have been unilateral cryptorchids or sons thereof. After five generations of selection for this trait, the incidence of cryptorchidism has increased from 1 to 74% of all males born in one population and from 1 to 5% in the other. Because of the wide divergence of results, autopsies were performed on the cryptorchid males produced in the later generations and their sires. The condition almost invariably observed in the high-incidence population was that of testicular retention. The prevailing condition in the other herd proved to be testicular atrophy. In the latter herd, sires that proved on autopsy to have an internal testicle sired litters with an average incidence of 12.3% cryptorchid males. For sires that proved to be unitesticular, the incidence of cryptorchidism among their male progeny was 2.3%. The latter figure is approximately the same as that reported as average for some breeds of pigs.

Treatment of Vibrionic Dysentery in Swine

3

In 1964, a severe outbreak diagnosed as vibrionic dysentery in 166 litters farrowed from January to March caused the death of 30.3% of the weaned pigs. This outbreak was not checked with an organic arsenic compound, sodium arsanilate, which had previously been relatively effective.

A subsequent farrow of 133 litters (June to August 1964) was infected and again sodium arsanilate was ineffective. Microscopic examination of smears of representative fecal samples showed the presence of a heavy concentration of vibrio-like organisms.

Pigs in two test barns, housing 140 and 172 pigs, respectively, were treated with tylosin tartrate. The pigs in one side of each barn were used as a control while the other pigs were being treated. Subsequently, the control animals were treated.

Both levels of tylosin used, 1 g and 2 g per gal (U.S.) of water, resulted in the disappearance of fluid feces within 48 hr of treatment. Soft, granular feces were still present 6-9 days after the start of treatment at the 1 g level, whereas in the case of the 2 g level of tylosin all feces were normal on the third day after medication started. Microscopic examination of feces collected on the third day of treatment still showed the presence of some vibrio-like organisms. However, these organisms could not be detected in examination of feces collected between 10 and 25 days after treatment. In this test there was no recurrence of dysentery.

Radiography with Swine

15

Radiographs obtained on 3,460 Lacombe and Yorkshire baby pigs were examined to determine the association between vertebral size and number, and carcass length. Carcass length increased approximately 1.3 cm/unit increase in vertebral number. Consideration of birth weight, slaughter weight, age at slaughter, and linear measurements of vertebrae at birth were not of value in improving the precision of prediction.

A subgroup comprising 615 Lacombe pigs at slaughter weight was X-rayed just prior to slaughter in order to assess the predictive value of X-ray measurements of the vertebrae and back fat at slaughter weight. Multiple regression, utilizing vertebral number and vertebral length at slaughter, explained some 34% of the variation in carcass length. X-ray measurements of back-fat thickness on the live animal were not found to be superior to the live probe in predicting percentage yield of lean cuts, and it was concluded that the radiographic technique was not superior to the simpler probe method for predicting cutout yield from measurements made on the live animal.

Prediction of Yield of Hog Carcasses

Ham and loin cuts of 930 carcasses were trimmed to provide yield data at three levels: commercial bone-in-yield, boneless yield, and boneless-defatted yield. As carcasses became fatter and heavier the proportion of ham decreased and the proportion of loin increased. Correlations between total fat (maximum shoulder plus maximum loin) and percent yield of the two cuts combined were highly significant and were not different for the three levels of trim. The correlations between carcass weight and yield were small and declined with increasing trim of the cuts (0.21 to 0.13). Percent yield of the boned-defatted cuts increased by 0.5% for each decrease of 2/10 inch in total back-fat thickness.

Efficiency of Half-carcass Analysis

The relative efficiency of half- vs. whole-carcass analysis was compared by chemical analysis of 36 swine carcasses. Although systematic differences between

sides were demonstrated ($P < .05$) for 16 of 32 traits studied, the analysis of single sides did not introduce serious bias into results. The efficiency of half-carcass analysis exceeded 90% for most chemical determinations except ash (54% for ham and 83% for carcass). Efficiency was high also for specific gravity and the conventional carcass measurements, whereas the efficiency of area tissue measurements in the ham was lower (63-86%). In general, half-carcass analysis was considered satisfactory although it was shown that the significance of treatment effects might be missed by sampling the single side in experiments of limited scope.

Predictors of Body Composition in the Pig

4

Data were obtained on body weight, total body protein, blood volume, and red-cell mass for a total of 88 pigs, ranging in liveweight from 9 to 103 kg. The relationship of total body protein to the other variables was analyzed by multiple regression techniques on both an overall and stratified basis. Over the entire weight range, body weight itself explained 98% of the variability in total protein. When the analysis was restricted to pigs weighing 81 to 103 kg, the contribution of body weight in predicting total protein decreased considerably (50%), with concomitant increase in predictive value of blood volume (8%). Red-cell mass had similar (8%) predictive value. It was concluded that blood volume and similar physiological measurements could be useful in predicting body composition in market-weight pigs.

Yield and Chemical Composition in Market Pigs

5

In a study of 100 pig carcasses, gross chemical composition of the ham, shoulder, loin, belly, and half carcass was determined for one side of the carcass with percentage yield (trimmed vs. untrimmed) of picnic, butt, ham, and loin (PBHL), and certain carcass measurements recorded on the other side. From covariance analyses, it was concluded that back-fat thickness of the carcass alone was of only moderate predictive value for total chemical carcass fat.

Carcass protein could, for most purposes, be predicted with satisfactory precision from the percentages of protein in the loin or in the ham, with residual standard deviations of 0.27 and 0.36% respectively.

Percentage yield of lean cuts was not an accurate index of the percentage of chemically determined protein.

Multiple regression equations were computed for predicting the percentage of protein in the carcass and percentage yield of PBHL from conventional carcass measurements. The residual standard deviations for predicting the percentage of protein were 0.49 for the males and 0.42 for the females; for percentage yield of PBHL these were 1.31 and 1.22 respectively. Total back-fat thickness was the most important single variable in predictions. Variances among sexes were non-homogeneous for the important traits; the females in all cases showed the greater variability. The results of regression analysis within sex indicated that, for maximum precision, a separate prediction equation for each sex was required.

Poultry

Selection for Egg Production in the Chicken

Nine generations of selection within a closed population consisting of 1,000 pullets were completed. Selection was based entirely on the production record during the 18-week period from housing at 147 days to 275 days of age. Genetic change was measured against the contemporary performance of a closed random-mated control population.

Substantial progress has been made, and continues to be made in the object of direct selection, production to 275 days of age. For this trait, the performance of the selected line has increased to 141% of the control line. Age at first egg (sexual maturity) for the selected line declined rapidly over the first two generations, but has remained relatively constant since.

The correlated response, production from housing to 500 days of age, has been disappointing. Improvement of this trait was steady to generation four, reaching 119% of control performance. Since that date performance has tended to fall and is now at approximately 108% of the control.

Egg quality traits have not shown any discernible trends.

PLANT BREEDING AND PATHOLOGY

Cereal and Oilseed Crops

Breeding improved varieties of oats and barley is emphasized at the Station in cooperation with the University of Alberta, Edmonton, and the research stations at Beaverlodge, Alta., and Winnipeg, Man. There is cooperation with other research establishments in Western Canada in the study and evaluation of new varieties of wheat, oats, barley, flax, rapeseed, and fall rye. Newly licensed varieties are continually being evaluated for production in Alberta in cooperation with all experimental units within the province.

Evaluation of Varieties

Wheat—Further evaluation testing confirmed earlier findings that Thatcher, Canthatch, Park, and Saunders are varieties best suited for production in central Alberta. Since stem and leaf rust rarely affect production in this region, the newly licensed variety, Manitou, has not proven outstanding. It is as late or later maturing than Thatcher and has failed to outyield it.

Oats—Yield, maturity, kernel type, and other desirable agronomic characteristics are the main factors in assessing oat varieties. To date diseases have been relatively unimportant. Varieties best suited in central Alberta, based on evaluation tests, are Victory, Eagle, Rodney, Harmon, Garry, Glen, and Pendek. Two new varieties, Fraser and Grizzly, licensed in 1967, have outyielded Victory and could replace both Victory and Eagle as suitable late maturing varieties when seed supplies are available.

Barley—Recent tests indicated that Conquest, licensed in 1965, and Galt, licensed in 1966, will prove suitable for production in central Alberta. Conquest, eligible for C.W. Grade, matured 3 to 4 days earlier than Parkland and outyielded it by 7% during the past 4 years. Galt, eligible for Feed Grades only, has matured about 5 days earlier than Jubilee or Husky and outyielded them by 5 to

7%. Varieties presently considered suitable in central Alberta include Husky and Jubilee as late maturing, Parkland and Betzes as medium maturing, and Gateway, Gateway 63, and Olli as early maturing. Some of these will no doubt be replaced with Conquest and Galt.

Flax—Raja and Redwing have proven the safest varieties because of their early maturity. Noralta, licensed in 1965, is a medium early maturing variety that has outyielded Raja and Redwing by 15 and 10% respectively.

Rapeseed—This crop is of increasing importance to central Alberta agriculture. Echo and Arlo, two Polish-type varieties, are adaptable to the area. Echo, licensed in 1966, has outyielded Arlo by 8%. Target and Tanka are two Argentine-type varieties that require 2 to 3 weeks longer to mature than Echo and should not be considered for production in any but the southeastern region of central Alberta.

Fall rye—Frontier and Sangaste are adaptable varieties. Sangaste is less winter hardy than Frontier, but has larger kernels and has outyielded it in the absence of winterkilling.

Oat Breeding

Evaluation of the random sampling method of oat breeding was continued through 1966. Results to date have indicated that this approach to breeding oats in areas where diseases are not a serious problem is sound. Eight short, strong-strawed lines from the cross Glen × Pendek, developed through random sampling, were evaluated at seven locations in central and northern Alberta in 1966. All of these lines approached or excelled Pendek, the higher yielding parent, in productivity and had superior kernel characteristics. Four showed sufficient promise to warrant their advance to the 1967 Western Canada Cooperative Tests.

In another cross, Beacon-Laurel × Garry, several lines have been selected that have excelled both parents. However, in preliminary tests none were as high producing as those from the Glen × Pendek cross.

Premature Leaf Yellowing in Oats

13

In 1963, a premature leaf yellowing condition was noted in a few lines from a Glen × Garry cross shortly after the panicles emerged. The color of the leaf blades, starting at the top and spreading to the base, changed from the normal green to a yellowish-bronze color. The sheaths were not affected. Although this condition was visually striking, there were no lesions and there was no indication of leaf curling or stunting of plants.

There was no sign of this yellowing in 1964, but in 1965 and 1966 the condition showed up on a percentage of the lines from a Beacon-Laurel × Garry cross and in some plots of Garry. As lines from a Glen × Pendek cross grown in adjacent plots were unaffected, suggesting a genetic influence, this condition will be watched closely.

Barley Breeding

Progress has been made on the development of varieties with resistance to scald, net blotch, and loose smut. Selections from crosses involving Gem, Feebar, and Cabana Cape possess a high degree of resistance to both scald and net blotch.

These have been used as sources of resistance to these diseases. Conquest and sister lines have been used as sources for loose smut resistance. Crossing and backcrossing programs with adaptable varieties are in progress to improve on agronomic characteristics.

Increased productivity is the main objective. Good malting quality varieties as well as high yielding feed varieties are being used as parents. Two selections have advanced to the 1967 Cooperative Barley Tests. Both matured about a week earlier than Jubilee and they yielded 6 and 8% higher in 13 tests in 2 years in central and northern Alberta. Both are highly resistant to scald and net blotch.

Net Blotch in Barley

Epiphytological studies indicated that primary infection of susceptible barley seedlings by the net blotch fungus, *Drechslera teres* (Sacc.) Shoem., can be brought about by seed-borne inoculum and by ascospores and conidia of this fungus from a previous barley crop. Spread of secondary infection was limited to short distances such as from one drill row to the next. The first seedling leaf was more susceptible to initial infection than subsequent leaves.

Leaf-detachment studies to simulate severe infection with *D. teres* indicated that a significant loss in yield can be expected only if the two upper leaves are rendered nonfunctional prior to heading. It can be inferred that climatic conditions and an abundant supply of inoculum at this stage of growth would materially affect yield and quality of barley.

Previous reports indicated that barley grown in soil with a high level of N shows a higher infection with *D. teres* than that grown in soil with a low level of N. Marked variations in infection occurred in barley grown on Brown, Black, and Gray soils regardless of the level of N. Nutritional studies conducted in hydroponic solutions indicated a marked increase in resistance when Ca was absent.

A technique using inoculated detached leaves floating on a 4 ppm solution of benzimidazole made it easier to differentiate between plants and provided a more reliable assessment of resistance or susceptibility.

Barley Seed Quality Studies

Seed size (14)—Further tests with two barley varieties showed that plants grown from large seeds were superior to those grown from small seeds in the rate of seedling growth and the size of the first two leaves. Results were inconsistent for the third and subsequent leaves. Rate of growth differences were more pronounced when plants were grown on vermiculite without added nutrients than when they were grown on soil. The length of the first and second leaves was positively correlated with spike weight and floret number, but the relationship was not strong enough to justify the use of leaf length as a selection criterion for yield potential.

Seed source—Yield tests showed that differences as great as 17% can result from using seed lots of the same variety produced under different environmental conditions. As chemical composition may be one of the factors involved in these differences, a study on this aspect was initiated in 1966. Seed stocks were produced under widely different fertility levels, and preliminary growth tests suggested marked differences in initial seedling growth from different seed stocks of the same variety.

Forage Crops

Breeding

Red clover—Varieties of red clover possessing resistance to northern anthracnose, caused by *Kabatiella caulivora* (Kirchn.) Karak., and to winter crown rot are essential to improving the productivity of this species. The 10 best selections in progeny tests during 1965 and 1966 produced significantly higher forage and seed yields than Altaswede and were superior in resistance to northern anthracnose. These selections will be combined and tested as a strain. Improved inoculation procedures have contributed to the increase in anthracnose resistance.

Colchicine-induced tetraploids derived from the variety Siberian have displayed excellent winterhardiness and early growth and are being evaluated for hay and seed production.

Crested wheatgrass—Cytogenetic studies have shown significant detrimental effects of supernumerary chromosomes on forage and seed yields, confirming earlier results. However, current investigations show that effects of these chromosomes can be evaluated much more accurately in controlled-cross progenies than in open-pollination progenies.

Management

Forage crop establishment—Over two seasons five mixtures of grasses with Beaver alfalfa and with Leo birdsfoot trefoil produced an average of 11% more forage when the companion oat crop was removed as pasture than when it was left to the silage stage. Early removal of the companion crop also increased the legume content (alfalfa and birdsfoot trefoil) and resulted in a reduced weed infestation in the stands.

Birdsfoot trefoil mixtures—Perennial grasses vary significantly in competition with associated legume species. This was demonstrated again in a study of six pasture mixtures of grass species with Leo birdsfoot trefoil. Trefoil, seeded at the same rate in all mixtures, contributed 42.7% of the total yield in mixtures with Olds creeping red fescue, but only 12.9% in mixtures with Carlton bromegrass. The trefoil portion in mixtures with Summit crested wheatgrass, Chief intermediate wheatgrass, a noncreeping strain of bromegrass, and Climax timothy amounted to 33.1, 24.0, 21.3, and 19.5% respectively.

In the second and subsequent crop years birdsfoot trefoil made insignificant contributions to the total production. Detailed studies are under way to determine whether the decline in productivity is due to incorrect management or to a lack of hardiness of the species.

Variety and Species Tests

Roamer alfalfa—This is a creeping rooted, very winter-hardy variety that outyielded all others (e.g., Ladak by 8%, Rambler by 3%) in recent tests. It has a higher degree of wilt resistance than Rambler and is a better seed producer.

Champ timothy—In a 2-year trial this variety produced 11% more forage and 7% more seed than Climax. It has made faster recovery after cutting than other varieties.

Boreal creeping red fescue—Boreal performed as well as or better than Olds in tests during 1965 and 1966. Its outstanding feature has been greatly improved uniformity in type and maturity, facilitating seed production.

Greenleaf pubescent wheatgrass—In 2 years of evaluation this variety produced significantly less forage than Chief intermediate wheatgrass.

Brown Root Rot of Sweet Clover

The differential in winterkilling between sweet clover varieties may be closely associated with the presence of brown root rot caused by *Plenodomus meliloti* Dearn. & Sanford. In 1966 the varieties Denta, Madrid, and Goldtop (U.S. varieties) had 4.5, 28.4, and 56.7% survival respectively, whereas Canadian varieties survived to the extent of 93 to 99%.

Brown root rot is present in most years, but is generally restricted to localized lesions. Pycnidia are usually rare in such lesions. The varieties that suffered damage showed very extensive lesions with numerous pycnidia.

Horticultural Crops

Rocket Tomato

The tomato selection LC14 was named Rocket and released to the trade in 1966. It is primarily suited to regions with short, cool growing seasons. It produces a heavy crop of round smooth fruits on small determinate plants. The fruit is four to six times the size of Farthest North, weighing from 40 to 65 g, with approximately equal maturity.

Maturity Variation in Early Varieties of Cabbage

Thirty-two varieties of cabbage, described as early by the seed trade, have been screened for degree of earliness under conditions at Lacombe. Varieties that reached maturity within 5 days of the earliest variety, in at least 2 out of 3 years, were considered to be in the early category. Viking Extra Early proved to be the earliest and most consistent, with an average maturity of 51.5 days from planting and a range of 4 days between seasons. Seasonal differences in other varieties varied from 9 to 28 days. Within the terms of this test only 12 varieties were rated as early. In the following ascending order of maturity they are: Viking Extra Early, Early Roundhead, First Acre, Early Greenball, Early Wonder, Earliana, Superior Early, Early Marvel, Golden Acre 84, Earlihead, Golden Acre, and Small Acre.

Raspberry Culture and Variety Trials

Covering (bending canes over and holding in position with soil on the tips) was compared with no covering involving six varieties over a 3-year period. This procedure was beneficial only when snow depth was sufficient to completely cover the bent portion of the cane. When snow cover was lacking, winter injury was greater to the bent canes than to the upright ones. Boyne proved to be the best variety, producing an average of 12.4 kg from a 9.1-m row, followed by Killarney, Chief, and Honeyking. Muskoka and Ottawa were unsatisfactory.

Gladiolus Mulch Trials

In a 3-year test of early, midseason, and late gladioli varieties, represented by Pink Lustre, Red Pepper, and Princess, clear polyethylene mulch advanced emergence 3 to 4 days and flowering 6 to 8 days with the early and midseason varieties. The late variety, Princess, emerged about 4 days earlier under mulch with no further advancement at flowering.

CROP MANAGEMENT AND SOILS

Nutrition and Management

Barley Production in Northeastern Alberta

The acreage seeded to barley in northeastern Alberta declined by more than 50% between 1951 and 1961. It was claimed that barley would not yield as well as wheat or oats. The possibility that disease had seriously reduced production was ruled out by plant pathologists, who found the incidence of disease no greater than elsewhere in the province.

From field experiments and other observations during two growing seasons on land with a history of low barley yields it was concluded that the problem was part of a more general problem of low soil fertility. Crops other than barley in the area also exhibited symptoms of nutritional deficiencies. It was demonstrated that the situation could be improved substantially through adequate fertilization.

Rotation and Manure Effects on Gray Wooded Soil

Fertilizers, barnyard manure, and growing of legumes, either alone or together in a rotation, have been very beneficial to yields of grain and hay on a Breton loam soil (Gray Wooded) at Athabasca. Yearly applications of 12 lb of N and 15 lb of phosphate per acre to all crops in a 6-year rotation (3 barley plus 3 brome–alfalfa) resulted in an average increase over the check of 320 lb of barley and 380 lb of hay per acre per year. Additional yield increases of 590 lb of barley and 760 lb of hay resulted from the application of 15 tons of manure just prior to breaking of the hay. The benefit of brome–alfalfa was indicated by a gradual decrease in yield of succeeding barley crops following breaking.

Time of Breaking Brome Sod

Preliminary results from a trial studying the effect of time of breaking brome sod on subsequent barley yields did not suggest an interaction between the incidence of root rot and the requirement for fertilizer.

Nutrient Deficiencies on Calcareous Soils

Potassium—Barley yields were increased by K fertilizer on 75% of the calcareous soils tested from 1964 through 1966. Yield response was also obtained at two sites on noncalcareous soils. Poor relationship existed between K response and any of the determined soil K fractions. Ca and Mg content and pH were taken into consideration. Studies on two sites with a deficiency history showed that wheat, oats, barley, flax, rape, and fall rye all responded to K. No responses were obtained on grass–alfalfa swards.

Phosphorus—All calcareous soils tested to date have had very low levels of P extracted by Olsen's or Brays No. 2 and barley has responded well to added P.

Trace elements—Cu and Mo have increased barley yields in field tests on some of the calcareous soils. Growth-chamber studies have shown a response to Cu, Mo, B, and Mn, on certain of these soils.

Delineation of Sulfur Response

Poor correlation was obtained between various soil S fractions and the yield response of radishes and alfalfa to S fertilizer in growth-chamber studies. Soluble

sulfate was not studied because of the lack of a suitable method of determination. A method using $Ba^{133}Cl_2$ has since been adapted and has given very good results on most soils extracted with water, dilute $CuCl_2$, or dilute HCl. On some soils, the recovery was not quantitative.

Measurement of water-extractable sulfate on soils from 13 field S fertilizer tests on legumes gave good delineation of the responsive and nonresponsive soils.

Yield response of barley, not previously noted, was obtained from S fertilization on a Gray Wooded soil at Chedderville. N, P, and K gave a yield of 9 cwt/acre, but with S added gave a yield of 23 cwt/acre. There are also indications that some of the Black Chernozemic soils, hitherto unsuspected, are S-deficient.

Liquid Fertilizers

A complete liquid fertilizer (10-20-10) was compared with conventional granular fertilizers in field experiments with barley. The liquid fertilizer was applied as a seed dressing, in the row at seeding time, and as foliar sprays. Seed dressing was ineffective, but yield increases obtained from the other two methods were equal to those obtained from equivalent amounts of plant nutrients applied in the granular form.

Slow-release Nitrogen Fertilizers

Several slow-release N fertilizers and nitrification inhibitors were studied in field experiments to determine the value of delayed availability of fertilizer N for barley production. Included among the materials were resin-coated $(NH_4)_2SO_4$, $MgNH_4PO_4.H_2O$, thiourea, and "N-Serve."

The slow-release N fertilizers and nitrification inhibitors were not effective in increasing the yield of barley above that obtained with conventional $(NH_4)_2SO_4$. Some increases in total N content of the grain were produced by the slow-release N fertilizers, but these were not consistent.

Weed Control

Bromoxynil

Bromoxynil has shown great promise toward the solution of the major shortcomings of the widely used herbicides 2,4-D and MCPA; namely, the effective control of weeds of the *Polygonum* family and high cereal crop tolerance, especially during the early growth stages.

Crop tolerance—Field tests over three seasons have shown that under most conditions wheat, barley, and oats will tolerate more than double the 4 oz/acre rate of bromoxynil required to control susceptible species. This high degree of tolerance extended from the two-leaf to the shot-blade growth stages. Under normal weather conditions there were no significant differences in tolerance between the commonly grown varieties of these crops.

The disconcerting necrotic spotting or scorch on the grain observed on some of the tests in each of the 3 years was traced through laboratory tests to very high humidity at spray time. In almost all cases the crop recovered quickly from this scorch with no apparent loss in yield. This was especially true when spraying was carired out in the early two- to three-leaf stage. However, when sprayed at the six-leaf stage on a very humid day four varieties of barley showed a differential recovery from the severe scorch. Tillering was delayed with the

variety Conquest to a greater extent than with Olli, whereas Betzes and Jubilee suffered no delay. All recovered with no apparent loss in yield, but these incidents indicated the inadvisability of spraying in periods of high humidity.

Control of weeds—Wild buckwheat, Tartary buckwheat, and pale and green smartweed with high tolerance to 2,4-D were readily controlled by bromoxynil applied at 4 oz/acre. Lambsquarters; pigweeds; and wild, ball, and wormseed mustards were not effectively controlled by this rate. However, a mixture (1:1) of bromoxynil and MCPA at a total dosage of 8 oz/acre gave excellent control. This low rate of MCPA did not measurably affect the cereal crops.

Common chickweed and corn spurry were not controlled by even high rates of bromoxynil.

Effect of environment on phytotoxicity—Bromoxynil gave excellent control of Tartary buckwheat under very droughty conditions at Vegreville in 1966. Dicamba, Picloram, and 2,4-D, also used in this test, gave very poor control. Studies in growth cabinets showed that moisture and temperature affected the phytotoxicity of these herbicides differentially. The activity of the systemic herbicides Dicamba, Picloram, and 2,4-D was greatest when soil moisture and temperature favored optimum growth of the Tartary buckwheat. Conversely, the contact herbicide bromoxynil showed its greatest phytotoxicity when cool temperature and low moisture conditions retarded the growth of the buckwheat. This differential phytotoxicity is important under field conditions where crop–weed competition introduces stress conditions for water, nutrients, and light.

Speed of action—Bromoxynil killed weeds by contact action within 2 days, whereas systemic herbicides such as dicamba and 2,4-D required 11 or more days to achieve the same degree of control. Studies at Lacombe and elsewhere have shown that weeds treated with herbicides continue to transpire water until dead. As expected, Tartary buckwheat treated with dicamba transpired significantly more water than when treated with bromoxynil.

The tests indicated that the quick removal of the Tartary buckwheat or other weeds from the young cereal crop will result in more available moisture, stronger seedlings, and a higher ultimate yield.

Residual Activity of Picloram

Picloram has proven to be highly potent for the control of Canada thistle, including its rhizomatous root system, but the persistence of the herbicide in the soil may be hazardous to succeeding crops. Applied at rates of 2 to 4 oz/acre in midsummer, instead of part of the tillage on fallow, it reduced thistle growth during the next season by 85 and 98% respectively. Injury to wheat following the 2 oz/acre rate was largely confined to reduced height and delayed maturity, but after the 4 oz rate significant yield reductions resulted. Higher rates, namely, 16, 24, and 48 oz, prevented thistle regrowth for at least three seasons, but the effects on barley and wheat were disastrous.

A bioassay technique with sunflowers, a highly sensitive indicator plant, permitted detection of as little as 0.005 ppm of Picloram in the soil. The use of this technique on soil taken at 0-3, 3-6, 6-9, and 9-12 inch depths on Picloram-treated plots showed that most of the chemical remained in the top 6 inches and the activity after 12 months in the field was about 25% of the original application. After 22 months the activity or recovery was 10% or less. The implications of

these early findings are significant because wheat was found to be sensitive to as little as 0.25 to 0.5 oz/acre of this herbicide in the soil. Barley and oats were tolerant to 0.75 oz/acre.

Concurrent work at the Experimental Farm, Scott, Sask., gave similar results despite the wide differences in precipitation and soil organic matter content.

Control of Wild Oat

Diallate and triallate at 1.25 to 1.5 lb/acre sprayed on summerfallow and disked in, or sprayed after seeding and harrowed in, gave satisfactory control of wild oats in barley. At 1.25 lb/acre triallate gave very similar control in wheat. Results were equally good when these treatments were applied in the fall. Good surface moisture was necessary to activate these chemicals because poor control resulted when the surface layer containing the chemical was dry when the wild oats were emerging. Crop residues also reduced the control, particularly if heavy enough to cover the soil. This aspect is a deterrent to the use of either diallate or triallate where grain is seeded on stubble land. Work is under way to determine the effect of straw cover on the efficacy of these herbicides and the possible use of granular forms to overcome it.

SOIL RESEARCH SUBSTATION, VEGREVILLE

Studies were continued on the effect of stimulated crop production on the soil, the applicability of soil fertility findings to other Solonetzic soils, and the possibility of improving these soils by the more radical method of deep plowing.

Weather

Moisture was ample for crop production in 1965, but extremely limited in 1966. At the Substation, hay production has been correlated (r=0.88) with October 1 to June 30 precipitation. The October 1 to June 30 precipitation was 12.50 inches for the 1965 crop and only 3.35 inches for the 1966 crop. The 1966 amount was the lowest recorded in over 60 years, being approached only in 1957 and 1964 when there were 5.57 and 5.88 inches respectively. It is interesting to note that for the 20-year period, 1907 to 1926, there were 8 years in which the October 1 to June 30 moisture exceeded 12 inches; 7 years in the next 20-year period, 1927 to 1946; but only 3 years in the last 20-year period, 1947 to 1966 (long-term records, courtesy Mr. T. D. Watts, Ranfurly, Alta.).

Frost was not a serious problem in either 1965 or 1966. The period with temperatures above 28 F (killing frost) was 113 days in 1965 and 114 days in 1966. However, the period with temperatures above 32 F was uncomfortably short in 1966, being only 54 days, the shortest for many years.

Effects of Nitrogen Fertilizer on Bromegrass Grown on Solonetzic Soils

Annual applications of NH_4NO_3 (400 and 800 lb/acre, giving 134 and 268 lb/acre of N respectively) were made to bromegrass growing on a Black Solonetz soil (Duagh Si. L.). Over a 5-year period the average yield per year was 1,340 lb/acre on the unfertilized plots, 4,303 lb/acre on the plots receiving the low rate of N, and 5,670 lb/acre on the plots receiving the high rate.

The N and K contents of the bromegrass were increased from recognized deficiency amounts on the check plots to sufficiency amounts on the fertilized

plots; the Na, Al, and Fe contents of the grass were somewhat reduced. There was a significant reduction in soluble and exchangeable Na in the A horizon of the fertilized soil compared with the check. This reduction in Na content, plus the greater growth of roots and the accumulation of nitrates in the subsoil of the fertilized soil, suggested a greater permeability in the fertilized plots.

Response to Nitrogen on Different Solonetzic Soils

Experiments in which fertilizers were applied to certain soils under bromegrass at the locations shown in brackets were conducted through a 3-year period on Duagh Si. L. (Vegreville), Torlea L. (Bruce), Thick Camrose L. (Camrose), Whitford L. (Chipman), and Kavanagh L. (Kavanagh) in the Black soil zone; Halkirk L. (Halkirk) and Torlea L. (Halkirk) in the Dark Brown soil zone; and Hemaruka L. (Coronation) in the Brown soil zone. The N deficiency noted at Vegreville was found to be common to Solonetzic soils, but the hay yield response to added N varied widely. The maximum yield was obtained by adding 800 lb of NH_4NO_2 (33.5-0-0) per acre to Duagh Si. L., Thick Camrose L., and Halkirk L.; 400 lb/acre to Whitford L., Torlea L., and Hemaruka L.; and 200 lb/acre to Kavanagh L. Precipitation was excellent on Kavanagh L. and the causes of the lack of expected response to N applied to hay crops on this soil are being studied. P and K provided variable but uneconomical yield increases.

Effect of Deep Plowing a Solonetz Soil

Plowing a Solonetz soil (Duagh Si. L.) to a depth of 22 inches greatly increased its water permeability as compared with a traditional depth of plowing (4 inches). The soluble salts, particularly Na salts, were reduced throughout the 60-inch depth sampled, as was the percentage exchangeable Na. Cereal crop yields were slightly but consistently increased by deep plowing, and the yield of an alfalfa-bromegrass crop was about doubled. There was a denser stand of bromegrass and a much denser stand of alfalfa where the soil had been deep plowed, and the depth of penetration of the main-root mass was more than doubled. Percentages of Ca and K were higher and Na lower in the crop grown on the deep-plowed than on the shallow-plowed soil.

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